Ambient Ammonia Monitoring Technologies

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EPA Science Forum

ETV: Collaborating for Outcomes

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Ammonia Emissions to Air

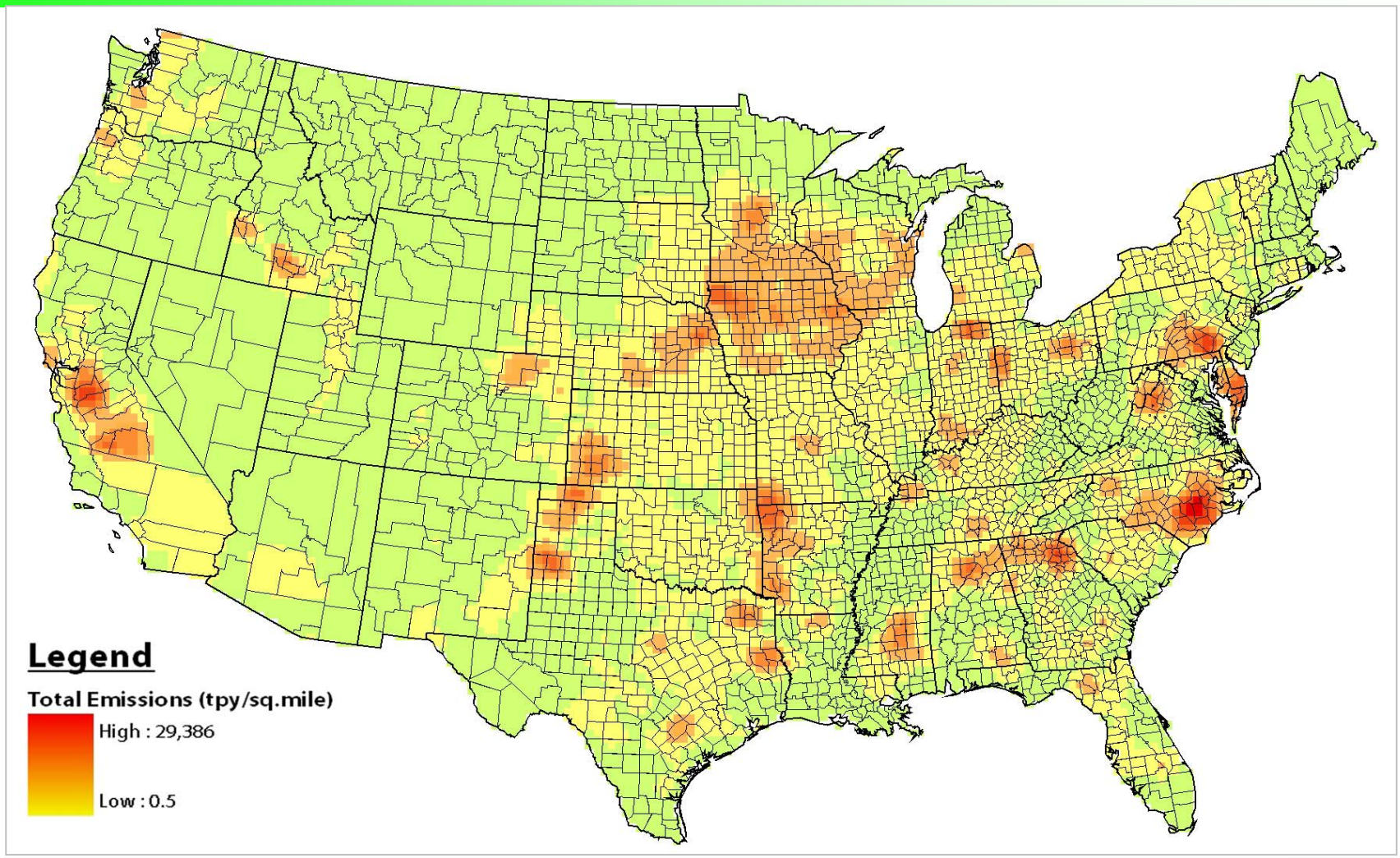
- ✓ Ammonia (NH_3) emissions to air contribute to formation of fine particles (PM2.5)
  - ➢ Human health effects by inhalation
  - ➢ Reduction of visibility (regional haze)

- ✓ ...and cause deposition of ammonia gas and particles to surface waters
  - ➢ Eutrophication of surface waters
  - ➢ Fish kills
  - ➢ Reduced biodiversity

Ammonia Emissions to Air (Cont'd)

- ✓ Animal feeding operations (AFOs) are estimated to be the largest single U.S. source of NH_3
  - ➢ ~65% of NH_3 emissions in U.S. are from livestock agriculture
- ✓ Ammonia emitted by microbial decomposition of animal waste accumulated at AFOs
- ✓ AFOs in U.S. emit approximately 2,200,000 metric tons of NH_3 each year

Ammonia Emissions from Livestock Agriculture (2002)



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Ammonia Regulation and Monitoring

- ✓ State regulation of AFO NH_3 emissions is increasing – emphasis on concentrated AFOs (CAFOs)
- ✓ Consolidated Emissions Reporting Rule requires states to report point source NH_3 emissions
- ✓ Uncertainty exists about applicability of Federal CAA, CERCLA, EPCRA regulations to CAFOs
- ✓ National Academy of Sciences has called for improved NH_3 measurements, to improve NH_3 emission estimates

ETV Response

- ✓ Collaboration with U.S. Department of Agriculture for field testing of commercial NH_3 monitoring instruments at CAFOs
- ✓ USDA National Soil Tilth Laboratory, Ames, Iowa
  - ➢ USDA efforts led by Jerry Hatfield, Richard Pfeiffer, and Kenwood Scoggin
  - ➢ USDA arranged field sites, supported test planning, collaborated in field test activities
- ✓ Test led by Ken Cowen and Ann Louise Sumner of Battelle

Ambient Ammonia Monitor Tests

- ✓ Phase I September–October, 2003, swine finishing farm in Ames, IA
- ✓ Phase II October–November, 2003, cattle feedlot in Carroll, IA
- ✓ Comparisons to reference method and challenges with NH_3 standards during continuous monitoring

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Ambient Ammonia Monitoring Technologies

Vendor	Technology Name	Analytical Technique
Aerodyne Research, Inc.	QC-TILDAS	Tunable diode laser absorption spectroscopy
Bruker Daltonics (Phase II Only)	OPAG 22 Open-Path Gas Analyzer	Open path Fourier transform infrared (FTIR) absorption spectroscopy
Molecular Analytics (Phase II Only)	IonPro-IMS Ammonia Analyzer	Ion mobility spectrometry
Omnisens SA (Phase II Only)	TGA310 Ammonia Analyzer	Photoacoustic infrared absorption spectroscopy
Pranalytica, Inc.	Nitrolux™ 1000 Ambient Ammonia Analyzer	Photoacoustic infrared absorption spectroscopy
Mechatronics Instruments BV	AiRRmonia Ammonia Analyzer	Selective membrane permeation with conductivity detection
Thermo Electron Corp.	Model 17C Ammonia Analyzer	Catalytic oxidation and chemiluminescence

Ambient Ammonia Monitor Field Sites

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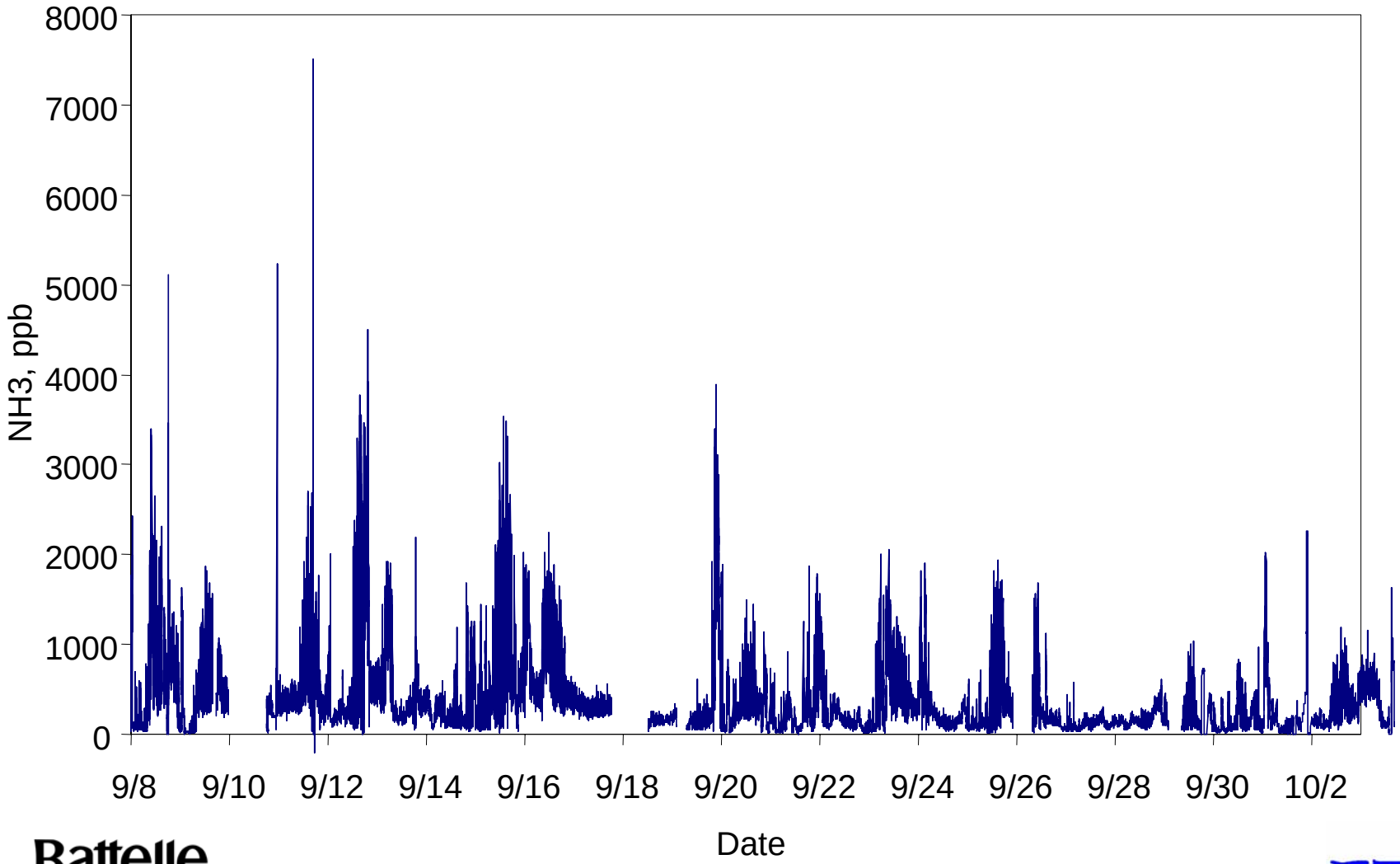
Phase I Ammonia Concentration – Monitor 1



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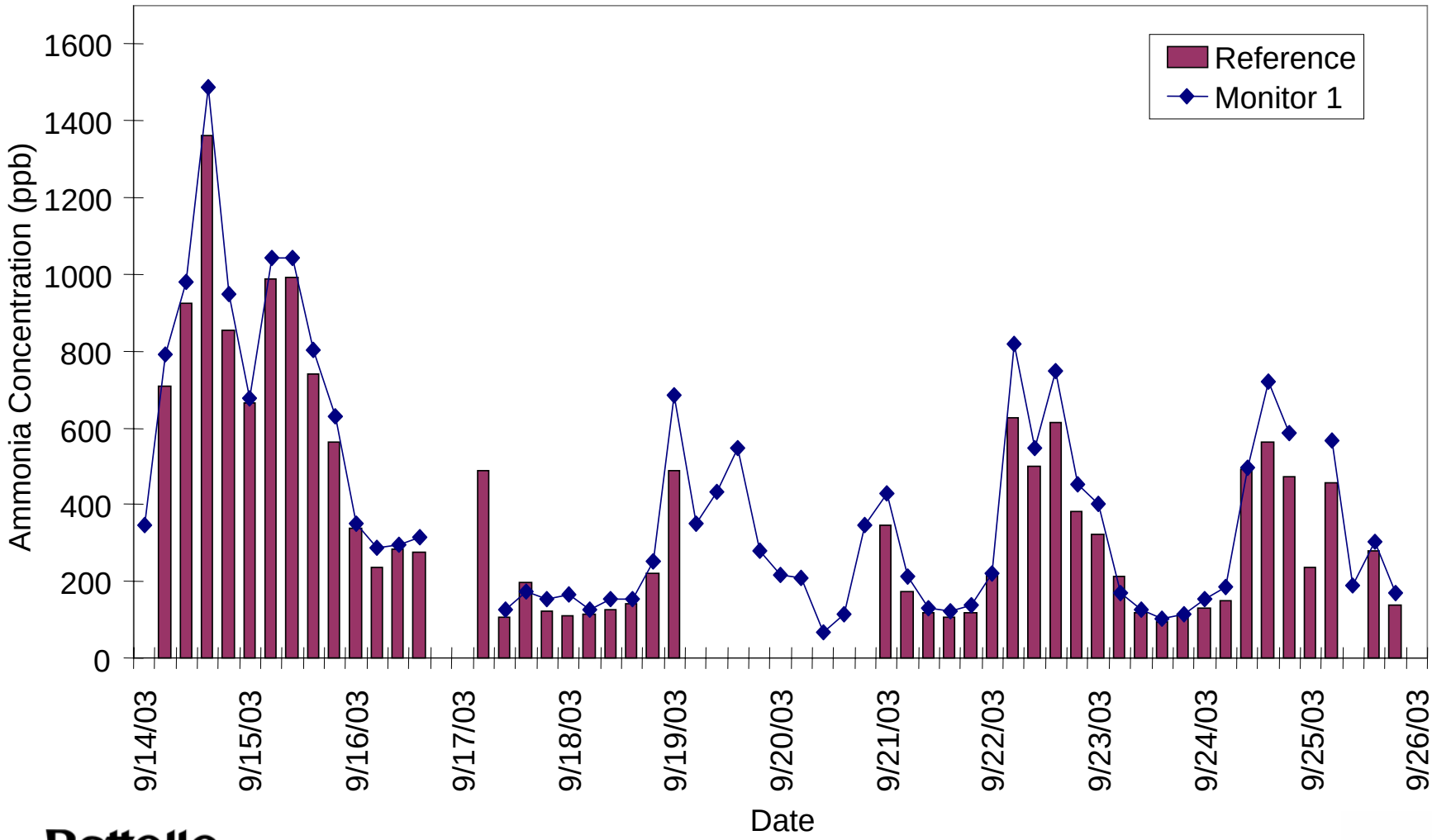
Comparability to Reference Method – Monitor 1



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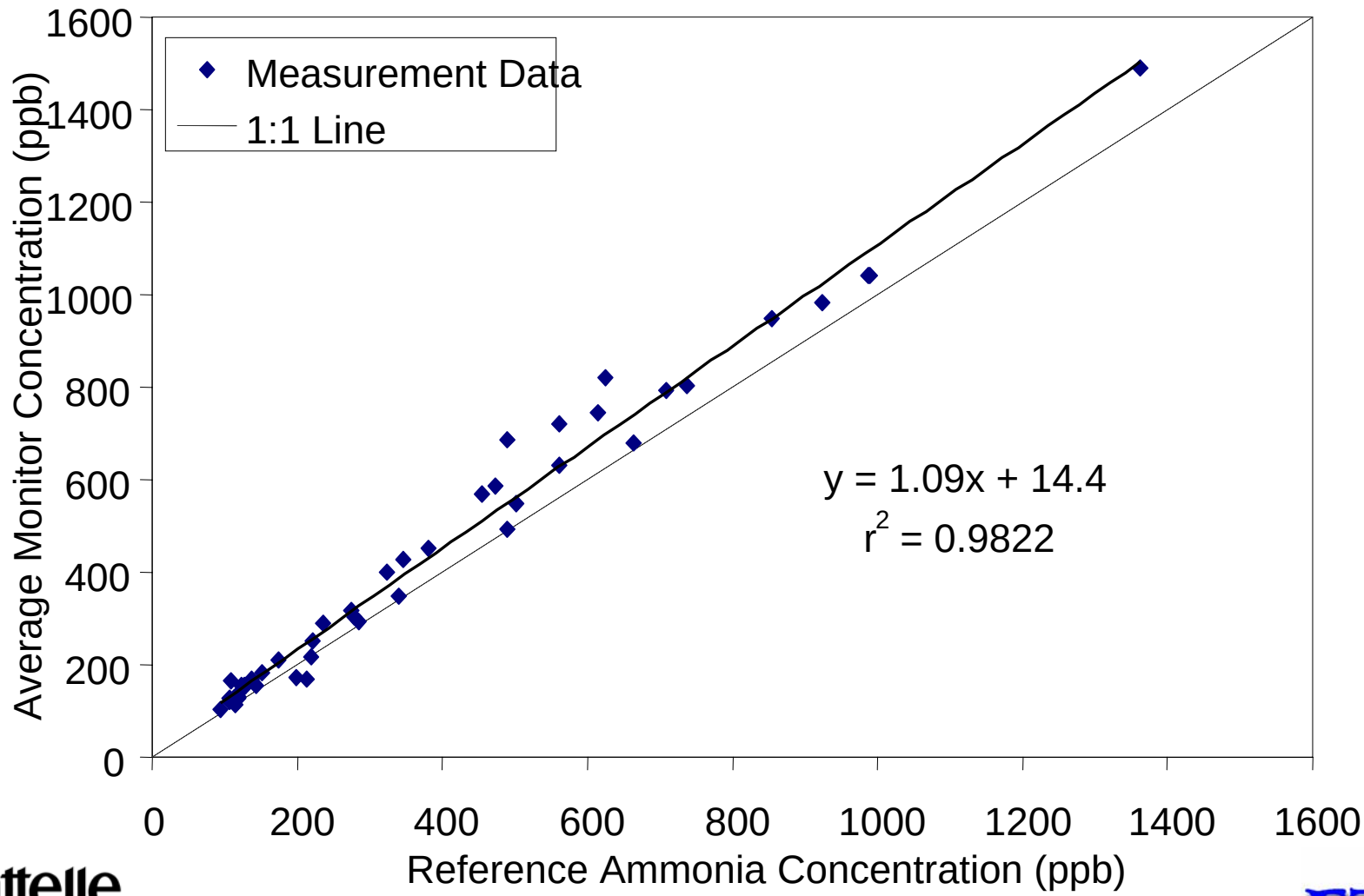
Comparability – Monitor 1



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Summary of Comparability Results (Comparison with Reference Method)

	Phase I			Phase II		
	Slope	Intercept (ppb)	r^2	Slope	Intercept (ppb)	r^2
Monitor 1	1.09	14.4	0.982	0.984	-9.5	0.994
Monitor 2	Did not participate			1.15	-4.1	0.994
Monitor 3	1.46	-6.7	0.984	1.10	21.6	0.979
Monitor 4	1.18	-1.4	0.976	0.41	58	0.538
Monitor 5	1.20	16	0.984	0.86	-0.5	0.990
Monitor 6	Did not participate			Insufficient data		
Monitor 7	Did not participate			1.56	-15.4	0.994

Summary of Linearity Results (Comparison with Ammonia Standards)

	Phase I			Phase II		
	Slope	Intercept (ppb)	r^2	Slope	Intercept (ppb)	r^2
Monitor 1	0.840	35	0.999	0.919	-8.8	1.000
Monitor 2	Did not participate			0.966	15.9	1.000
Monitor 3	1.25	13.2	1.000	0.586	-12.2	0.999
Monitor 4	1.28	136	0.996	1.02	-2.4	1.000
Monitor 5	1.03	-24	1.000	0.90	-0.6	1.000
Monitor 6	Did not participate			0.583	24.9	0.914
Monitor 7	Did not participate			0.815	1.1	1.000

Impact of the ETV Test Results

- ✓ EPA expects to select 28 CAFOs for a two-year monitoring study under the voluntary Air Quality Compliance Agreement with the animal producers
- ✓ NH_3 monitoring protocol specifies chemiluminescence, photoacoustic IR, open path FTIR, or UV-DOAS, depending on facility
- ✓ ETV test results may be relevant to selection of NH_3 measurement methods for the study

Impact of the ETV Test Results (Cont'd)

- ✓ Adoption of NH_3 monitoring technologies by CAFOs could have large market impact
- ✓ Background for EPA Office of Water's CAFO effluent guidelines estimated a total of about 15,000 large and medium CAFOs
- ✓ Monitoring may be needed at numerous CAFO's to address state and Federal (e.g., CAA, CERCLA, EPCRA) regulations

Impact of the ETV Test Results (Cont'd)

- ✓ Potential benefits of NH_3 monitoring at CAFOs
  - ➢ Improved emission estimates
  - ➢ Assessing need for emission reduction measures
  - ➢ Assessing effectiveness of emission reduction measures
  - ➢ Decrease in emissions, with consequent environmental and health improvements

- ✓ "...a 10% reduction in livestock ammonia emissions can lead to over $4 billion annually in particulate-related health benefits." (McCubbin, et al., ES&T, 2002)

Impact of ETV/USDA Collaboration

- ✓ Collaboration was mutually beneficial to ETV program and USDA research related to CAFOs
- ✓ Collaboration is continuing in testing of hydrogen sulfide (H_2S) monitors at CAFOs
- ✓ Issues are H_2S exposure of workers, odor, and atmospheric emissions
- ✓ H_2S monitor test ongoing at a swine farm, May-June of 2005, with two technologies

Summary on Ammonia Monitors

- ✓ ETV reports on the seven NH_3 monitors are available at www.epa.gov/etv/verifications/vcenter1-30.html
- ✓ Poster on the ammonia monitor test presented at this meeting by Robert Fuerst of EPA/NERL